

TRIP REPORT – CHINA
August 23 – September 4, 2004

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Subject: White pine blister rust (*Cronartium ribicola*) resistance of *Pinus monticola* to sources of rust in China.

Purpose: The main purpose of the trip was to meet Dr. He Wei (a pathologist at Beijing Forestry University) and discuss with him the logistics of a collaborative project between Dr. He and the USDA Forest Service (via Dorena Genetic Resource Center in Region 6). The project involves an evaluation of white pine blister rust resistance in *Pinus monticola* to two diverse races of *Cronartium ribicola* present in China (one is possibly another species of blister rust that affects white pines – see He et al. 2003).

Significance: Information supplied by this project will give valuable insights into the potential danger of new accidental introductions of sources of blister rust from China as well as insights to long-term durability of resistance of materials developed in Region 6 and Region 1 rust resistance programs (knowledge of evolutionary potential of *C. ribicola*). A similar trial has been setup in Germany, and seedlots have also been sent to groups in eastern Canada and U.S. for testing.

This was the first personal meeting with Dr. He Wei, the principal cooperater on the joint blister rust resistance project currently underway. The project had originally been setup after numerous email exchanges starting in fall 2002 and assistance from Gary Man, FS International Forestry. Dr. He and his graduate students would take the lead on the project, with inputs as needed from me as well as others.

The trip was to visit Dr. He at Beijing Forestry University (BFU) and confer with him about the trial setup. BFU served as the home base of my trip, and Dr. He as the primary host.

Few, if any, blister rust workers in the U.S. are knowledgeable about the extent of blister rust impacts in China, and the trip was also to increase this awareness (blister rust is now a big concern in some parts of China). Trips to see blister rust on native Chinese white pines and possibly *Ribes* were on the schedule. I was also scheduled to give a seminar on 'Breeding for disease resistance in trees' at BFU. In addition, I would visit an area in Tianjin impacted by emerald ash borer (EAB) and make other contacts relating to genetics, resistance, and forest health.

Dr. He was my host and translator during all days of my visit.

23-25 August:

I flew out of Eugene, Oregon on 8/23 and arrived in Beijing at ~5pm on 8/24. A few hours after arriving, Dr. He, Dr. Hou-ran Wang (forest geneticist), Ms. Li (graduate student of Dr. He's) and I met for dinner (on 8/24). I had met Dr. Wang when he had given a overview talk at the IUFRO 2.02.15 working group (Breeding and Genetic Resources of Five-needle Pines) meeting in Medford, Oregon in July 2001 (proceedings published by RMRS in 2004).

Dr. He has been a teacher at BFU since 1982 and is now an associate professor. There are several other pathologist and entomologists on the faculty at BFU. Ms. Li is a graduate student working on fungal problem with chestnut fruits. While in Beijing I stayed at the Beilin Hotel (adjacent to and associated with BFU).

Wed., 8/25 was a semi-free day, but Dr. He and I did meet to discuss potential white pine blister rust (wpbr) spore collections for a potential project to investigate the molecular genetic variation in white pine blister rust – in conjunction with Dr. Paul Zambino (RMRS). I am trying to help facilitate collections to finally resolve issues such as the amount of genetic diversity in *C. ribicola* and the geographic origin of the pathogen (still debated). We also discussed our upcoming trip on Thursday to Jilin province.

My luggage got sidetracked and I didn't received it until I returned from the Jilin trip (Aug. 28). Dr. He was able to borrow a pair of shoes I could use for field visits until my luggage arrived.

26-28 August:

Travel day on 8/26: Fly to Jilin Province (Changchun), drive to Huadian city, with Mr. Pi Zhongqin (Forest Protection Leader, Jilin province). Discussions on **blister rust** and general forest health. Dinner with Hongshi Forestry Bureau personnel. On 8/27, drive from Hongshi Forestry Bureau to field site to see blister rust on *Pinus koraiensis* (Figures 1 & 2). It was also a chance to see larch and hardwood forests. Larch and *Pinus* are planted with some *P. koraiensis* on ~2500 ha of the 10,000 ha area (Fig. 3).

From discussions held, it sounded like blister rust had not always been a problem here on *P. koraiensis*, and some thought it might have originated in Korea. They have had teams of ~30 people inspect the forest for infected trees, and 'paint' them to prevent sporulation and to kill the canker (Fig. 2). They have the labor force available to do this.

Based on the forested area I visited, cankers on *P. koraiensis* seem to have little swelling (Fig. 1 & 2) and would be hard to spot without looking very closely (when aecia are not present), even when the canker length is extensive. Perhaps ~20% of trees were thought to be infected in some areas. Cankers can be several feet (or more) long (Fig. 1).

Branches on trees have been pruned to ~2m and most cankers are low to the ground, so we didn't see any branch cankers on this tree. The pruning would also obviously reduce

the incidence of rust cankers in the area. We didn't have any luck finding *Ribes* or *Pedicularis* with infection (alternate hosts of wpbr) in the area.

After lunch on 8/27 at the Forestry Bureau, we looked at samples of wood with blister rust (Fig. 4), and viewed their collection of insect and animal specimens. Blister rust and *Dothistroma* are on 'quarantine' list in this area.

Returned to Beijing on 8/28 at ~2000.

29 August:

Took train to Tianjin, with Dr. He and Jian Wu (Division Chief, State For. Admin. Dept. of Afforestation, Forest Pest Control Division). Tianjin is one of four cities administered by the central government. Visited plantations damaged by **emerald ash borer** (EAB) – damage to *Fraxinus* species.

Stop #1: trees heavily impacted by EAB – some dead, many damaged, some relatively unaffected (Fig. 5). Unaffected trees are mostly 'smooth bark' type (noted by my hosts), but it is unclear whether this is a different species than the trees that are damaged (trees which were generally 'rough, deeply fissured'). [Note: prior to coming to China, Gary Man (FS – International Forestry) had advised me that there might be three species present in the planting]. The trees here were planted on reclaimed land that has high salinity, so stress may also be a contributor at some level. It would be helpful to have someone (taxonomist?) spend more time with the trees to sort out which trees are which species; then the within-species variation in resistance/susceptibility would be clearer (including whether any of the North American trees show any level of resistance or tolerance). Also, part of the trial is evidently being used for a bi-control study and this might have impacted the observed results (at this stop or in surrounding plantings). It might also be possible to trace the origin of the seedlings from nursery records.

Stop #2: ~600m away was a much healthier looking ash planting, a few stressed trees (with large seed crops). This may be from a different species – relatively smooth bark (slightly rough), not as deeply fissured bark as in the other planting (nor any trees with bark as smooth as the 'smoothest' in the other planting at Stop #1).

Dr. He and I drove back to Beijing.

30 August:

Visited BFU to see pine seedlings for inoculation study and look at room that would potentially be used for blister rust inoculation. The seedlings were maintained outside under shade trees (Fig. 6). The *P. monticola* seedlings had all died soon after germination (dampening off?) and before my arrival, while the *P. koraiensis* and *P. armandii* seedlings were still alive. I noted that it would be possible to send additional seed, and I would ask for inputs from nursery specialists/pathologists to raise potential success of a subsequent sowing.

I also visited Dr. Jiang-hua Sun (Research Ecologist, Institute of Zoology, Chinese Academy of Sciences) to discuss issues relating to exotic pests. Dr. Sun mentioned that part of the *Fraxinus* plantings in Tianjin had been ‘sprayed’ and that may be why some areas looked much better than the first area visited. Dr. Sun is writing an overview paper on emerald ash borer (EAB) in China (with some other researchers). He is also writing a paper on biocontrol of kudzu (with Kerry Britton, FS-WO); and he has previously worked with Nancy (Rappaport) Gillette (FS – PSW Entomologist).

31 August – 2 September:

Visit to Sichuan Province and Chengdu Forestry Bureau. Meet with Dr. Yang Zuozhong (leader of Forest Protection Unit – I’ve had email correspondence with him since 1999 (after a previous visit to China) regarding blister rust, but hadn’t met him before. Dr. Yang has worked with blister rust for more than a decade and had previously sent me some information regarding relatively recent serious blister rust impacts on *P. armandii*. Dr. Yang has previous experience in inoculation of both pines and *Ribes* with blister rust (Yang 2003). Interestingly, it appears that Dr. Yang used a basidiospore suspension for his inoculation (Yang 2003 and personal communication) (I don’t think this has been successful in the U.S).

We drove to Guangyuan (~3 hours) and met with several other forest protection officials. Field visit to an area with *Pinus armandii*, *Ribes* and blister rust. We saw blister rust cankers on the *P. armandii* (Figs. 7 - 11), but no infected *Ribes*. Also, saw *Pinus massoniana* with gall rust (*Cronartium quercuum*) as well as infected oaks in the understory. Visited the Guangyuan Forestry Bureau (forest protection unit) – Maps at the office showed that the range of *P. armandii* and *C. ribicola* closely overlap and are north of Guangyuan. Blister rust was definitely a problem on *P. armandii* in this area (most of area is plantations) to the extent that it appears they have reduced (or stopped) planting it. There is no baseline information currently available in China on frequency and levels of genetic resistance within *P. armandii* to blister rust (but inoculations of *P. armandii* in North America., including at Dorena GRC, indicate that the species is highly resistant to races of rust present in North America). The rust on *P. armandii* may be a different species of *Cronartium* (He 2003). If so, it is unknown how this rust would affect our nine native species of white pines.

3 September:

Presented seminar ‘Breeding for Disease Resistance in Forest Trees – Classical Approach’ at BFU. Met some staff and students that had worked with chestnut and poplar. One of the Ph.D. students (Prof. Li Changzhu, Lichangzhu2003@yahoo.com.cn)) later sent me information (in Chinese) about cultivation of chestnuts in China.

4 September:

Met Dr. He’s new graduate student, Ms. Kuang Hongling (Fig. 12), and traveled to the airport. Flight back to Eugene.

Trip Overview: The trip accomplished the objectives of meeting Dr. He and seeing his setup for a blister rust resistance trial of *Pinus monticola*, as well as meeting his new

graduate student who might take this project on (specifically, Ms. Kuang Hongling). It also afforded the opportunity to meet Dr. Yang who has also worked with white pine blister rust and written about the problem in parts of Sichuan province. The trip also gave a better appreciation that blister rust is a problem in at least some parts of China, and this was relatively unknown to us in the U.S. There was some speculation in those I visited that blister rust was not native to some parts of China. There was also some consideration to doing exploratory screening of Chinese white pines for their relative resistance to blister rust (one or more species of blister rust). If this is done, then we might be able to aid in study design or interpretation. There also appeared to be some interest in our resistant *P. monticola*. Dr. He was a very good host and spoke English well, most of the other colleagues of Dr. He spoke little or no English, but this wasn't a problem during technical portions of the trip or meals (Fig. 13). He had mentioned there might be interest in hosting a pathologist in the future and that BFU might have funds available for the 'in country' portion of expenses. A pathologist with broad interests, but strong background in blister rust might be a good fit.

Follow-up: I have maintained contact with Dr. He, and we have sent him new seedlots of *P. monticola* (and one seedlot of *P. lambertiana*). I've contacted some nursery specialists about the sowing in China and have supplied Dr. He with some additional information that should help success of the new sowing. Dorena GRC has supplied Dr. He with a draft copy of our inoculation manual for blister rust, also with other publications dealing with white pines and blister rust. Ms. Kuang Hongling has also recently begun email correspondence with me regarding her anticipated efforts in inoculating various pine species from N. America and China. There may be a small prototype inoculation in September 2005 (using ~5 month old seedlings), with a larger inoculation in 2006 (using ~1.5 year old seedlings). I believe Dr. He has sent a portion of the seed to Dr. Yang to grow and test in Sichuan province. I will continue to correspond with Dr. He, Ms. Kuang, and Dr. Yang through the course of the trials. Depending on the success of the inoculations there could be interest in a follow-up visit, or perhaps a visit by Dr. He to some facilities in the U.S.



Figure 1. Large basal canker on *P. koraiensis*
(Photo courtesy of Hongshi Forestry Bureau,
Jilin province).



Figure 2. *P. koraiensis* with 'painted' canker.



Figure 3. *Pinus koraiensis* in Jilin province.



Figure 4. Dr. He showing blister rust infection on sample from *P. korainsis*



Figure 5. Emerald ash borer damage (rough bark tree affected), smooth bark tree healthy.



Figure 6. Pots for blister rust resistance trial on Beijing Forestry University campus.



Figure 7. Dr. He showing blister rust basal canker on *P. armandii* in Sichuan province.



Figure 8. Two *P. armandii* with basal cankers.



Figure 9. Basal canker on *P. armandii*.



Figure 10. *P. armandii* killed by blister rust.



Figure 11. *P. armandii* plantation.



Figure 12. Ms. Kuang Hong Ling and Dr. He Wei in front of BFU.



Figure 13. Dr. He, Dr. Sniezko, and Dr. Yang (from right) at lunch.

APPENDIX A

Project Description:

From email discussions beginning in fall 2002, a white pine blister rust resistance project has been initiated (in 2003) with a researcher (Dr. He Wei, Beijing Forestry University) in Beijing, China. FS International Programs has provided some project support for this work in China. This project is related to a series of other blister rust resistance trials initiated by Dorena Genetic Resource Center (involving groups in Germany and eastern North America). The project will involve inoculation in China of an array of the best resistant western white pine seedling families from Region 6 resistance program (based at Dorena Genetic Resource Center) and a F₂ orchard seed lot from Region 1 program. One of our *P. lambertiana* seedlots will also be tested. China may host several species of blister rust capable of infecting North America pines and two of these ‘species’ will be used for inoculation. In addition, these species may have much more genetic diversity (and perhaps virulence/aggressiveness) than the ‘strain’ of *Cronartium ribicola* currently found in western North America. Little is known about the resistance/susceptibility of native China white pines to these two ‘strains’ from China, and two Chinese species will be scheduled to be included (may provide the first information on relative susceptibility of these species to blister rust from China). Bulk seedlots of *P. armandii* and *P. koraiensis* would be used. The Forest Service program will lend expertise in resistance screening technology to assessment of some species native to China – this would also allow direct comparison of relative resistance of the Chinese species and our most resistant western white pine. The FS operational programs would gain knowledge of whether current materials are resistant to other strains of rust, this will help in assessing durability of resistance.

There is also interest by researchers from two FS research stations in investigating genetic variation of blister rust, and Dr. He Wei could be very instrumental in participating in collections. We have just begun email correspondence on this potential project. My visit would help solidify a working partnership. It would help open the door to other cooperative projects.

Travel to field sites in two provinces to see the impacts of blister rust on native forest trees will also be included (I have previously been in correspondence with a pathologist in Sichuan who has mentioned a serious blister rust problem emerging on one of their native white pines in the last 15 years). This would involve visiting field sites in areas closer to where the pathogen may have co-evolved with some species of five-needle pines in China. There would be an opportunity to observe presence or absence and impacts of blister rust on species native to China and to discuss potential nature of resistance of these local species. Leaves with blister rust will be collected for use in inoculations in China. The field visits will include sites that have many of the same genera of conifers that are present in the PNW.

I also have contact with a prominent forest geneticist within the Chinese research group (located in Beijing) and the visit would allow solidifying a working relationship (Dr. Wang was an invited speaker at the IUFRO 5-needle pine genetics/breeding/disease resistance workshop in Medford, OR in 2001).

Develop contacts with other specialists world-wide that deal with blister rust, especially aspects of screening and breeding for resistance. There are several possible joint activities that could be developed. Potentially meet researchers dealing with a range of pathogens which could foster future collaborations on non-native invasive species in North American forests.

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